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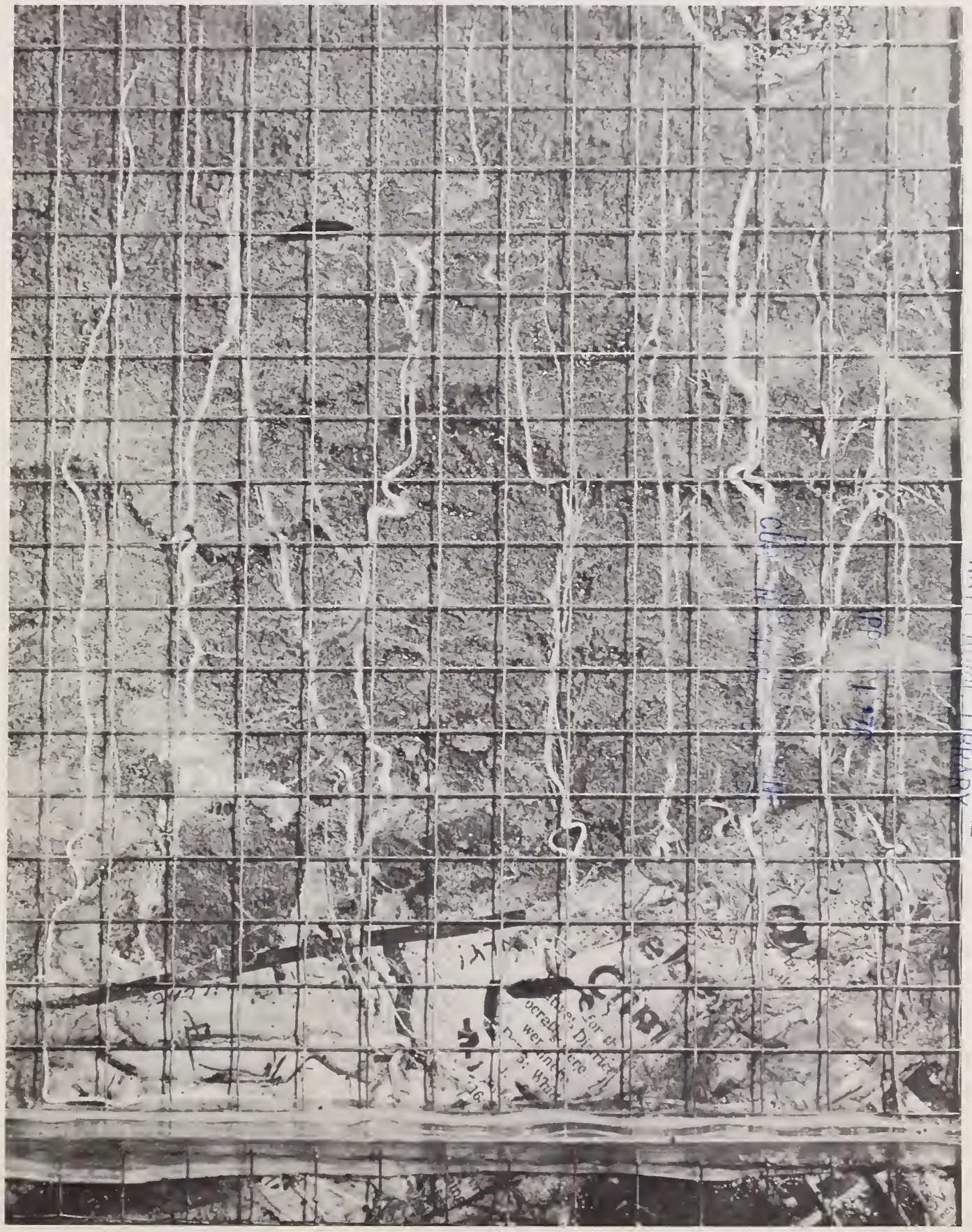

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The Goal: Bigger Calf Crops

The beef cow is raised to produce calves. When she fails—and about 7 to 8 million U.S. beef cows do not reproduce annually—the costs are high. The cattleman not only loses income when his calf crops are smaller, but also the value of a year's feed and labor in maintaining each unproductive cow. Production inefficiencies, in turn, result in costlier beef for consumers.

In this era of scarcity, with its complex economic pressures, the cattleman must do better to compete. A basic fact of his economic life is that land resources are dwindling, forcing him to achieve greater efficiency without materially increasing herd size. Put simply, more beef must be produced per cow.

A promising but still experimental approach toward reaching this goal lies in inducing multiple births. At best, natural multiple births occur infrequently—in fewer than 1 percent of the cows. What is the potential for inducing multiple births? In today's beef herds an average of 74 calves are raised to weaning age per 100 cows bred. If the calf crop of only 20 percent of the nation's beef herds could be increased by 10 percent—with no additional brood cows—the annual supply of meat available to consumers would be increased by 390 million pounds. Indeed, scientists envision calf crop increases of 25 to 35 percent.

Currently, ARS scientists are injecting hormones that cause cows to produce not one but several fertile eggs. Then the cows are given hormones which bring them into estrus, or heat, all at once. Synchronization of estrus enables the artificial insemination of entire herds over a short time. When the calves are born, they are allowed to nurse and thus obtain the milk's colostrum and its disease-fighting antibodies; after 3 days they are weaned to cold whole milk or starter rations. Although these methods have achieved calf crops of 112 percent, problems remain.

One major problem concerns maintaining viable pregnancies in treated cows. Their fetuses often begin dying off at 25 to 35 days; the hormone progesterone is under test as a promising remedy. Another problem is that in multiple births there are fewer placental attachments per calf; this could cause less efficient transfer of nutrients and wastes. Scientists are studying the exchange of these metabolites to ascertain the nature of possible difficulties. Practical induction of multiple births is a decade or so away. In time, however, agricultural science will enhance beef's competitive position—beef and its savory goodness will remain basic to our national diet.

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Cover: What could pass for abstract art is, in reality, a profile of root systems growing through refuse in an experimental landfill model. ARS researchers at Auburn, Ala., are studying new ways to prevent landfill water seepage from contaminating ground water systems (1174X1741-3A). Article begins on page 8.

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Earl L. Butz, Secretary
U.S. Deparment of Agriculture

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Transponder-fitted dairy cows feed at the experimental ration-dispensing system. Mr. Hyde monitors the feed flow which automatically shuts off when each cow has consumed her feed allotment (1174X1719–16).

Just what she needs...

'and that's all Bossy gets'

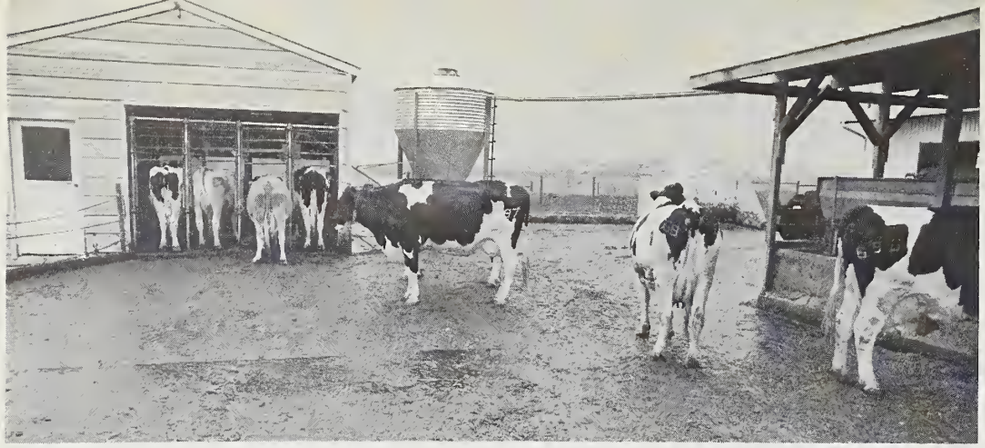
DAIRY COWS may someday consume individualized rations at their leisure from an electronic feed-dispensing system under development. A whole herd would have access to the system, but with each cow getting only the amount of feed that she needs to maintain peak milk production.

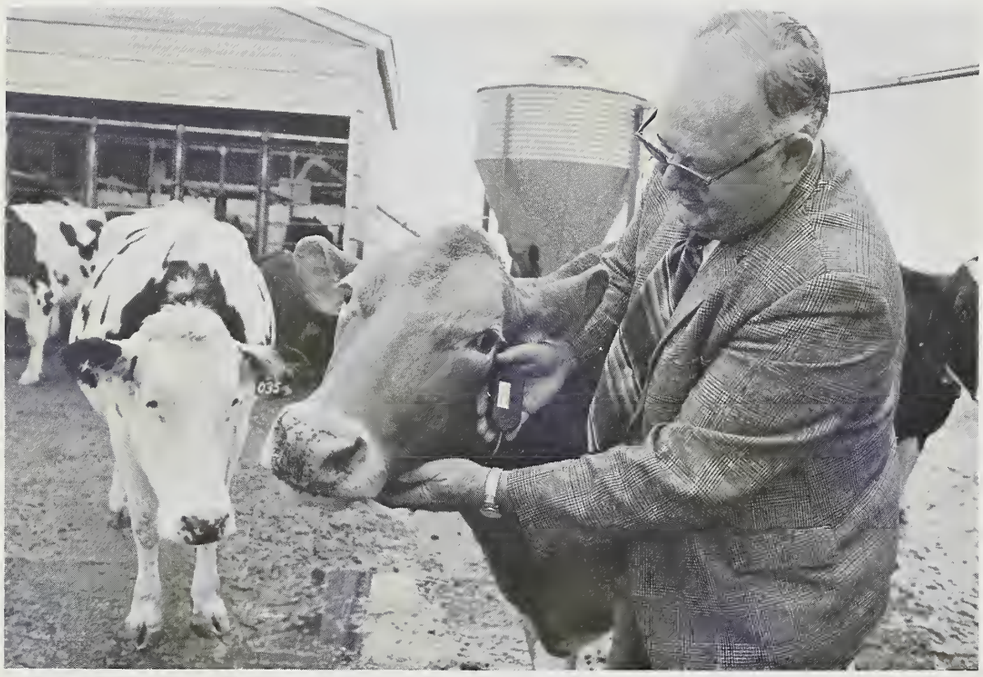
Researchers of ARS and the Illinois Agricultural Experiment Station, Urbana, are designing the system to save labor as well as feed resources, thereby overcoming inefficiencies of presently used feeding methods.

When milk cows are group-fed a complete ration outside the milking parlor, ARS agricultural engineer H. B. Puckett says, it is necessary to transfer cows from one group to another to maintain the proper energy intake as it relates to an individual cow's milk production. Moving animals to another group is time consuming and affects the social order of the new group which, in turn, lowers milk production. Group-feeding also results in poor control of the grain consumption (energy intake) of the individual cow.

When high-producing cows are fed in the parlor, they may not have adequate time to eat production-geared rations while they are being milked. Moreover, Mr. Puckett notes, feeding in the parlor creates sanitation and fly problems.

ARS agricultural engineer Gary M.





Upper: Four cows take their turn in the structure housing the automatic feed-dispensing system. The animals roam in a loose-housing area and may eat at their leisure (1174X1730–9). ***Lower:*** *Mr. Puckett inspects a transponder designed to trigger the feed-dispensing system (1174X1729–33).*

Hyde, Mr. Puckett, and their Illinois colleagues have an alternative feeding method that liberates each cow from the hassle of struggling for her share of grain at a community trough or during milking time. Rather, she eats at her leisure from a stall in a loose-housing area. She wears an electronic device called a transponder that fits on a neck collar. The transponder, which serves as a kind of "credit card," activates a feed dispenser when the cow sticks her head into a feed trough.

The transponder could be compared to a device used to operate an electronic garage-door opener, Mr. Puckett says. Each cow's transponder is electronically tuned, or coded, to identify her according to her milk production. When the cow moves her neck into a loop-formed interrogator antenna to reach the feed trough, high-frequency radio energy flows to the transponder. The transponder's coded memory device begins to charge electronically and drives a signal generator which, in turn, causes feed to dispense slowly as the cow eats.

When the memory device becomes fully charged, the dispenser stops and the cow gets no more feed. With the passing of time, the electronic charge leaks off slowly and the cow may then eat again. Her ration is computed on a 12-hour basis. She may consume it in many or few installments. Feed that is available to her at any time is dependent upon the allotted feed she has not eaten during the preceding 12 hours.

The agricultural engineers found that, with reasonably accurate calibration of the feed dispenser and transponder, they could limit errors in feeding rates to within 10 percent of prescribed allocations—better control than that exercised in normal in-parlor feeding systems. Performance trials showed no significant difference in milk production, whether the cows were hand fed in the parlor or fed with the electronic feeder control.

Mr. Puckett says the number of cows that can be accomodated by one stall depends upon how fast they eat and their tendency to dawdle. Accordingly, to hold the cost of the system per animal to a minimum, studies are underway on dairy cow behavior in the environment of the electronically equipped stall.

Presently, the researchers know that feed ingestion rates are affected by the shape of the feed bowl and the feed's moisture content and texture. Dawdling time depends upon such conditions as the cow's place in the bovine "pecking order," comfort of the stall, and the weather outside of the stall.

Early in their experiments, the researchers used a feed-dispensing station with a single stall that accommodated 20 cows. Now, they are observing patterns of stall use with up to four stalls. The stalls are equipped with timers and recording devices to indicate the amount of feed consumed by each cow, the time of day, the amount of time each cow spends in the stall, and the cow's identity.

Mr. Puckett says, "Automatic individual feeding, when coupled with mechanized management techniques, offers opportunities only dreamed of a few years ago."

Illinois researchers cooperating in the studies include agricultural engineer Elwood F. Olver and dairy scientists Kenneth E. Harshbarger, Sidney L. Spahr, and Archie L. Devore. □

Shallow wells to drain soils

RESEARCH indicates that a series of shallow wells joined together and connected to a single self-priming pump can effectively drain slowly permeable soils, provided they are underlain by shallow aquifers. Such soils are difficult or impossible to drain by conventional pipe drains.

These so-called, well-point drainage systems can effectively control the level of high water tables and also permit and enhance leaching of salts from the soil either by irrigation or rainfall. ARS agricultural engineer Robert J. Rektorik, U.S. Fruit, Vegetable, Soil & Water Research Laboratory, Weslaco, Tex., conducted the research.

The new system permits better water table depth control than conventional pipe drains. For example, water tables can be lowered in the soil in anticipation of high rainfall periods for effective leaching of salts and for storage of the high-quality rainwater. Then, the good rainwater can be maintained at a shallower level to make it readily available to plants.

In the Lower Rio Grande Valley, where shallow ground water tends to increase in salinity with depth, Mr. Rektorik found that well effluents have a higher salt content and export more salt from the area per unit of effluent than do pipe drains.

A long-term benefit may prove to be the improvement of ground water to a usable point through long-term replenishment of saline waters with rain water and good quality irrigation water.

The all-plastic well-point system employed by Mr. Rektorik in this ongoing study was installed in a 50-acre plot of clay loam at a cost of $4,000. The 12 wells are pumping from an aquifer that ranges from 15.5 feet to 27 feet below the surface. Pipe drains, used in an adjacent field as a control, are placed at depths of 5.5 to 7.5 feet. The pipe drains discharge into a sump and their effluents must be pumped into an adjacent shallow ditch.

The well points extract water from a more permeable zone than do the pipe drains and increase the hydraulic gradient in the sand stratum, causing more lateral inflow into the well-point-drained field. This accounts for the higher drainage volume.

Over a 3-year period electricity costs averaged $1.71 per acre per year. Per acre cost of electricity during the same period for the pipe drain system was 70 cents. The well-point system removed .36 acre-foot of water per acre per year while the pipe drain removed only .19 acre foot per acre per year.

The well-point system removed a calculated 7.5 tons of salt per acre. The pipe drain system removed 3 tons.

Moreover, pipe drain systems in the Lower Rio Grande Valley normally cost $150 to $200 per acre to install, whereas the well-point system costs from $100 to $130 per acre. The interest alone, according to Mr. Rektorik, on the difference in capital investment may well pay pumping costs of as much as $5 to $7 per acre per year.

Life of the all-plastic well-point system appears unlimited. In the past, metal screens on the well-points were subject to clogging due to scaling, probably the result of electrolytic precipitation. The all-plastic system, which includes plastic screens on the well points, was examined after 33 months in place and showed no scale accumulation or other evidence of deterioration.

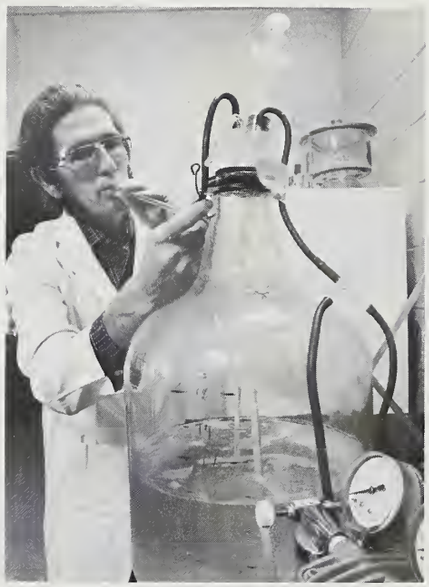
The system used for this study basically consists of a single line of wells in a long field. This is the most economical configuration to build since it minimizes the length of manifold pipe and trench required.

The well heads and connecting pipe manifold are all buried in the field at depths of 2 to 3 feet to place them below plow depth and permit normal farming operations. Only the pump remains above ground level. Polyvinyl-chloride pipe is used exclusively in the system for well and manifold piping because of its low cost and resistance to corrosion.

According to Mr. Rektorik, the straight-line arrangement does not produce the most uniform water table drawdown, but narrow fields can be adequately served by a single line of wells. Wider fields require multiple lines or a grid of wells to get adequate drawdown. Onsite exploratory borings are necessary for good system design.

Mr. Rektorik points out that the design of well-point systems is an inexact science at this time. He foresees a growing trend toward well-point drainage—at least in the Lower Rio Grande Valley where the soils are alluvial and sand layers at depths of 10 to 30 feet below the soil surface are the rule. □

Halting the ripening process



Left: Dr. Owens takes a culture sample of rhizobium bacteria from a large fermentation flask to check the progress of cell growth and rhizobitoxine production (1074X1674–28). ***Above:*** *Dr. Lieberman applies purified rhizobitoxine to tomatoes and apples. The chemical will be drawn into the fruit when subjected to vacuum. Later, the fruit will be tested for slowing down of the ripening process (1074X1675–4A).*

Above left: *Plant physiologist Charles Sloger examines a soybean plant suffering from the disease "rhizobium induced chlorosis." Rhizobitoxine was first discovered in soybean plants affected with this disease (1074X1674–17).*

LOOKING SADLY at peaches, pears, and bananas going soft and brown, what produce handler—indeed, what shopper—has not dreamed of a way of slowing down the ripening and aging of fruit?

ARS researchers have come upon a series of compounds that may just make that dream come true. Much more is unknown about how these compounds work than is known, but in some way they interfere with the basic biochemical mechanisms that cause fruits to go on aging after they are harvested.

The compounds are known to chemists as enol-ether amino acids. One of them, called rhizobitoxine, was first discovered in the root nodules of a diseased soybean plant. It was shown to be responsible for producing the disease symptoms in the plant. Rhizobitoxine is produced by certain strains of the bacterium *Rhizobium japonicum*, which normally performs the vital function of fixing nitrogen in soybean nodules. In the years since that discovery, commercial researchers have discovered other enol-ether amino acids with similar properties in the fermentation broths of other bacteria.

Rhizobitoxine was initially of interest to soil scientist Lowell D. Owens, of the Plant Physiology Institute in Beltsville, Md. Dr. Owens envisioned rhizobitoxine as a weed killer, finding that it interferes with the synthesis of a precursor of methionine, an essential amino acid that is converted to protein in the growth of a plant (AGR. RES., May 1969, p. 11).

Plant physiologist Morris Lieberman, of the Agricultural Marketing Research Institute, Beltsville, Md., foresaw even more exciting possibilities for rhizobitoxine, and he teamed up with Dr. Owens to do further research on the chemical. If rhizobitoxine interferes with methionine synthesis, Dr. Lieberman reasoned, it might also reduce the production of ethylene, the ripening hormone produced from methionine. He treated apple tissue, pea seedlings, tobacco leaves, and banana slices with rhizobitoxine and then measured the ethylene produced. A dramatic inhibition resulted, sometimes as much as 90 percent and more, as compared to untreated controls.

Dr. Lieberman assumed that ethylene production was being suppressed by preventing the synthesis of methionine. To test the assumption, in one of his experiments on apple tissue, he removed rhizobitoxine and introduced more methionine. Interestingly enough, methionine, which by itself greatly en-

hanced ethylene production, had no such effect when it was added after rhizobitoxine.

This disproved the assumption, but indicated that rhizobitoxine prevents methionine from being converted to ethylene. Apparently the ethylene-forming system is irreversibly inactivated by rhizobitoxine. Thus the system is unable to proceed with the production of ethylene, even though more methionine is made available to it.

It is a far cry, however, from finding a chemical suppressant for ethylene production to developing a practical means of controlling the ripening and aging of fruit. The ARS scientists have had some preliminary success in vacuum infiltrating apples with rhizobitoxine solutions. The treated fruit produced less ethylene and respired more slowly than untreated controls. This was shown by measurements made daily for over a week, both immediately after treatment and after several months of cold storage.

In a test for ripeness, somewhat greater pressure was required to penetrate the rhizobitoxine-treated apples than to penetrate similarly stored controls. Although the results were not conclusive, they provided some indication that the treated fruit was less ripe.

These preliminary experiments only suggest some retardation of ripening by rhizobitoxine. They tell nothing about what the treatment may have done to the quality of the fruit, nor its subsequent ripening characteristics. The early work has been promising enough to prompt further investigation of these points. If such research establishes the value of the treatment, then it would remain for regulatory agencies to perform the extensive testing necessary to determine its absolute safety. Finally, still further study would be needed to develop the most efficient and satisfactory method of performing the treatment.

So it may be a while yet before the dream of slower-ripening fruit comes true. But a start has been made. □

Cattle grubs and vitamin A

SKIN is considered the first and possibly the most formidable barrier against many parasites. Changes that disturb its normal integrity are important. One such change is a deficiency in vitamin A.

When deficient in vitamin A, the skin typically becomes dry, thin, and scaly, the sebaceous or fat glands begin to atrophy, and lesions appear around hair follicles.

In an 8-month test, ARS scientists found that cattle deficient in vitamin A appear 50 percent more susceptible to infestation by larvae of the common cattle grub (*Hypoderma lineatum*) than cattle fed a normal, adequate diet.

These are findings of research entomogolist Richard E. Gingrich and biological technician Colan C. Barrett who conducted the tests at the U.S. Livestock Insects Laboratory, Kerrville, Tex.

The results are particularly important to cattlemen who rely heavily on pastures and hay during the winter months. During that time native grasses, which are rich in vitamin A during the growing season, lose the vitamin at a steady rate as they cure. Hay is also frequently poor in quality or loses vitamin A because of improper or long storage.

The tests were conducted with twelve 6-month-old Hereford calves born in May after the local annual period of activity of adult cattle grubs had passed. The calves were housed in a screened enclosure during the entire test period the following fall and winter when native flies were again active, thus they had never been infested by grubs.

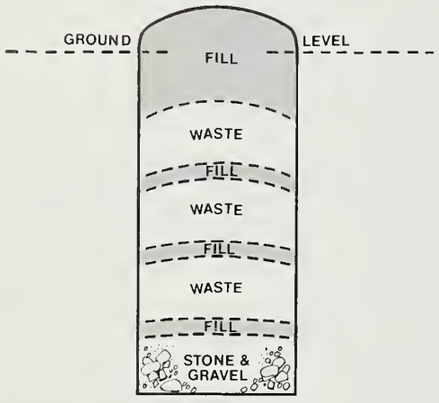
Before the animals were infested, six were conditioned for 85 days on a vitamin A-enriched diet of cottonseed hulls, cottonseed meal, northern white oats, and minerals. During the same period the other six animals were fed a similar diet that lacked vitamin A. Serum level of vitamin A was determined for each animal immediately before infestation.

The six animals in each test group were randomly divided into two subgroups of three animals each. Calves in one subgroup from each test were infested by injecting newly-hatched larvae into the subcutaneous tissues of the neck. Each animal in the other subgroups was infested on the neck by a gravid, female fly tethered to a hand-held thread; 5 days later hairs containing eggs were examined to determine hatch.

The dose of exposure ranged from 40 to 126 larvae per animal and averaged 91 larvae over all 12 test animals. After infestation all animals were fed the vitamin A-rich diet until the end of the test.

Final counting of grubs showed that 39.7 percent of the grubs hatched on the animals survived and penetrated the skin of vitamin A-deficient animals as opposed to only 21.2 percent found in the animals on the complete diet. Vitamin A made little difference on survival of grubs injected beneath the skin; 57.9 percent in vitamin A-deficient animals and 52.7 percent in animals fed the vitamin A-rich diet. □

The half-scale landfill models are equipped underground with glass walls inlaid with wire grids for fast and accurate measurement of root development. Mr. Browning makes a root count on one of the panels (1174X1739–10).



Mr. Browning and Dr. Molz (right) collect runoff samples from one of the three full-scale lysimeters used in the landfill study (1174X1742–33). The drawing above represents the alternating layers of material used in the lysimeters (PN–2875).

Evapotranspiration . . .

SANITARY LANDFILL sounds hygienic, but it's still a hole in the ground constructed by man to dispose of his all-too-solid wastes. A properly designed and operated sanitary landfill is an economical way to handle municipal refuse, but it has a major drawback. Leachate—water seepage from the refuse—becomes grossly polluted and, in a poorly designed landfill, may contaminate the surrounding groundwater system.

It has proved costly to retard the seepage moving into and from the landfill by using linings, like asphalt or clay, on the sides and bottom of the landfill, or to collect the fluid and treat it chemically. With experiments conducted at the Auburn University Sanitary Engineering Field Laboratory in Auburn, Ala., researchers decreased the amount of water available for seepage by removing the water from the landfill directly. Roots of transpiring plants were used effectively and economically to dry the refuse and the surrounding soil.

Transpiration—the emission of water vapor from plant leaves—is the key to drying landfills with plant roots. Occurring simultaneously, transpiration and evaporation, known as evapotranspiration, result in the transfer of water from soil to plant to atmosphere. As the water moves from the roots up through the plant, transpiration occurs mainly at leaf surfaces through stomata or pores, the size of which depends on solar radiation, relative humidity, air temperature, and wind speed. The sun is all-important because it stimulates "guard cells" to open their leaf pores.

ARS agricultural engineer V. Douglas Browning, with hydrologist Fred J. Molz and graduate engineering student Steven R. Van Fleet of Auburn University, designed and constructed three full-scale experimental landfill lysimeters which were filled with muni-

Above left: *The scientists check growth on one of the vegetated lysimeters (1174X174–22).* ***Below left:*** *Mr. Browning cleans unwanted grass from bare control, half-scale model. As with the full-scale lysimeters, two of the half-scale models were planted with vegetation and one was kept bare as a control (1174X1740–7).* ***Below:*** *Laboratory technician Leigh W. Nox uses "Kjeldahl" analysis to determine the amount of nitrogen present in leachate samples from the lysimeters (1174X1739–33).*

the key to reducing landfill leachates

cipal refuse—household garbage, waste paper, tin, plastic, and miscellaneous trash. Refuse was mixed in quantities considered typical in standards set by the Environmental Protection Agency. The waste was alternated with layers of ground fill in the 12-foot-high lysimeters as in a typical landfill operation.

Slash pine, black locust, thorny elaeagnus, bristly locust and two grasses, all hardy, deep-rooting plants, were grown on two models; the third was kept bare and used as a control. Roots proliferated rapidly through the top 2½ feet of cover soil and the first refuse layer on vegetated models.

The researchers also constructed similar half-scale landfill models in glass-fronted rhizotron bins which enabled them to observe and record root penetration and growth.

Catch-basins were designed to collect and hold any leachate produced at the bottom of the lysimeters for chemical analysis. Landfill temperatures and all fluid volumes entering the surface and leaving the base of the simulated landfills were recorded.

Quantitatively, evaporation is measured by lysimeters. "Essentially, lysimeters are upright tanks or cylinders, containing representative material, which maintain a water balance," Mr. Browning said. "We can conveniently record the difference in weight or volume of liquid added as precipitation or lost through seepage and evapotranspiration."

In slightly less than a year, the three lysimeters began to produce leachate. The unvegetated control model produced 104.06 gallons of fluid compared to 51.02 gallons and 14.81 gallons for the vegetated models. Elaeagnus and pine formed more dense plant cover and accounted for the lowest volume of leachate.

Predictably, the unvegetated control lysimeter produced the most dilute leachate. To determine the potency of leachate, the researchers relied on measurements of chemical oxygen demand, which is the amount of oxygen needed to break down the hydrocarbons into harmless carbon dioxide and water; the total Kjeldahl nitrogen, which is the nitrogen determination in an organic compound; and the total solids. The net improvement factor due to the presence of plants was a significant 3.57—72 percent less pollution than for the unvegetated control model.

Landfill vegetation not only has good potential for reducing leachate volume, but vegetation also retards erosion, stabilizes the landfill mass, and reduces the rate of surface settlement.

Property owners near a vegetated landfill would clearly profit. With plants like slash pine and elaeagnus, that unseemly hole in the ground could be an attractive site instead of a sight. □

Cattle plod in single file across a shortgrass range in Northern Colorado (0974X1536–8).

Herbicides stimulate protein content

RECENT RESEARCH indicates that some herbicides not only control weeds on rangeland, they also increase the protein content of range grasses and protect plants from drought. These herbicides, of the triazine group, include atrazine, simazine, and cyanazine.

In a 3-year study in the Central Great Plains, atrazine increased protein yield 63 percent per acre, increased the nitrate-nitrogen content of herbage (though not to hazardous levels), and increased dry matter yields of rangeland.

In another 3-year study the nitrogen (N) concentration in herbage was increased an average of 29 percent by atrazine, 23 percent by simazine, and 14 percent by cyanazine. Dry matter yields were not affected in this study.

In greenhouse studies, atrazine decreased root growth of blue grama seedlings, but increased N and phosphorous uptake per unit weight of root 3- to 7-fold.

The studies also show that when N fertilizer is added to rangelands being treated with these herbicides, the protein content and herbage yields increase even more. This shows that the beneficial effects of fertilizer and herbicides are additive.

Triazines control most annual weeds found on shortgrass ranges. They are particularly good for ridding ranges of undesirable six-weeks fescue. Because cattle will not eat six-weeks fescue, it seriously interferes with grazing in the years when it is abundant.

Atrazine protected the desirable grass, blue grama, from a disastrous combination of drought and nitrogen fertilizer. In 1971, a year of average precipitation, the frequency of occurrence of blue grama was not affected by application of either 20 or 40 pounds of N per acre.

In the drought year of 1972, the 20-pound N application reduced the frequency of blue grama from 64 to 52 percent while the 40-pound application reduced the frequency to 36 percent. These represent estimated losses in yield of 40 to 50 percent and 85 to 95 percent, respectively.

However, where atrazine was applied with the N fertilizer there was no reduction of blue grama.

ARS range scientist Walter R. Houston, Crops Research Laboratory, Fort Collins, Colo., states that research elsewhere has shown that atrazine reduces transpiration and helps plants make more efficient use of the available moisture. He also indicates that investigations are currently under way to determine the fundamental role of atrazine in protecting blue grama from drought.

The only disadvantage to the use of triazines is their effect on two valuable cool-season grasses. Both western wheatgrass and needle-and-thread decrease when the triazines are applied. The beneficial effect of atrazine on the warm-season blue grama and detrimental effect on cool-season grasses points out possible application to warm-season grasses in other areas.

Dr. Houston says that in most years the N treatment alone without the triazines is the most profitable way to increase protein yields on shortgrass range in the Central Plains. This is because of the low cost of N fertilizer compared to the higher price of herbicides. However, grazing trials are needed to establish firm economic values.

Dr. Houston conducted the tests in cooperation with Colorado State University Experiment Station at the Central Plains Experimental Range near Nunn, Colo. □

Dr. Houston samples native plants on a shortgrass range test area in Colorado by measuring their frequency of occurrence. Botanist Marilyn Samuel (recording data) will use the same techniques in her studies at the U.S. High Plains Grassland Research Station, Cheyenne, Wyo. (0974X1535–18).

Zinc may affect learning

FEEDING a zinc-deficient diet to experimental rats during the last third of pregnancy causes poor learning ability in their male offspring in young adulthood.

This discovery at the Human Nutrition Laboratory, Grand Forks, N. Dak., and results of other studies with zinc, conducted there in cooperation with the University of North Dakota, may have implications in human nutrition. The researchers do not know whether zinc deficiency occurs in human fetuses, but they do suggest that it may be prudent for pregnant women to consume foods rich in zinc during pregnancy.

The behavioral study with rats was unusual because it was conducted jointly by biochemical and behavioral scientists—ARS medical officer Harold H. Sandstead and University of North Dakota psychologist Edward S. Halas. This team previously learned that young rats that had been deprived of zinc during infancy failed to learn to go through a maze as quickly as those that had been starved or adequately fed (AGR. RES., June 1973, p. 16).

The more recent study involved three groups of 60-day-old male rats, all of which received adequate zinc in their diets after birth. Rats from one of these groups—deprived of zinc before birth—were slower in learning to avoid electrical shock than rats from the two control groups. The rats were warned of impending electrical shock by an electric light and audio tone.

Dams of both control groups had received adequate amounts of zinc during pregnancy. Dams of one of the control groups, however, were pair fed—allowed only the amount of food eaten by zinc-deficient and appetite-depressed dams.

Young adult offspring of both control groups continued learning to avoid the shock throughout the 10 days of testing. In contrast, the previously zinc-deficient rats' heeding of the warning light declined midway through the experiment. Dr. Halas said that the decrease in response was probably due to inability of the rats to tolerate stress induced by the 1 milliampere level of shock used. One milliampere is near the threshold of shock tolerated by normal rats. Some stress improves learning ability but too much stress produces an opposite effect.

During their peak performance in the tests, which were run in series, offspring of zinc-deficient dams avoided shock 35 percent of the times when the condition-stimulus light was lit. By comparison, offspring of pair-fed and normally-fed dams learned to avoid shock as much as 70 and 80 percent of the times, respectively.

Dr. Halas and Dr. Sandstead also observed that offspring of the normally-fed rats were more active than the others. All of the rats appeared healthy.

Complementary studies at the Human Nutrition Laboratory focus on biochemical abnormalities in developing brains of zinc-deprived rats, the mechanism of intestinal absorption of zinc, and interactions of zinc with other nutrients.

Zinc is essential for formation of nucleic acids and protein, and it is an activator of numerous enzymes, Dr. Sandstead said. Manifestations of zinc deficiency include poor growth, delayed sexual maturation, loss of taste and smell, and impaired healing of burns and wounds. Dr. Sandstead said that although precise requirements for the trace element in man's diet have not yet been determined, new recommended daily allowances by the National Academy of Sciences' National Research Council include a recommendation for zinc. □

Goal: Curbing erosion during wind-driven rain

WHETHER heavy rain is accompanied by a strong wind can materially affect the protection against erosion that is provided by a mulch of crop residues over a cloddy soil surface.

ARS agricultural engineer Leon Lyles points out that the amounts of protective mulches needed to control water erosion have been determined under no-wind conditions. Wind-driven rains are common, however, on the Great Plains where stubble-mulch tillage is a recommended conservation practice on fields not in crops.

Dr. Lyles, agricultural engineer Jerry D. Dickerson, and research assistant Neal F. Schmeidler measured the effects of wheat, corn, and sorghum mulches on silty clay loam clods in a Manhattan, Kan., wind tunnel-rain-tower facility. They administered the equivalent of 1.76 inches of rain per hour, which occurs about once every 2 years in central Kansas, for 45 minutes with a wind of 25 miles per hour and with no wind.

Without wind, unprotected field-moist clods (85 percent saturated) disintegrated only slightly more than air-dried clods with 90–percent mulch cover. With a 25 mile-an-hour wind, however, 1.65 times as much soil was detached from field-moist clods and 2.68 times as much from air-dried clods as with no wind.

The scientists explain that field-moist clods absorb additional water slowly and thus resist erosion. In contrast, air-dried clods absorb water rapidly, expand, are then less tightly held together and readily susceptible to raindrop impact or wind drag.

As expected, the amount of soil loss was less as a greater percentage of the soil surface was covered with mulch. The wheat, corn, and sorghum mulches were equally effective if expressed as percentage soil cover. □

Dr. Moon prepares to give infectious TGE virus to a baby pig (held by Dr. Lambert) through a stomach tube and syringe. Their research on the pathogenesis of TGE has revealed some major pathological changes in the intestinal villi of infected pigs (0874X1253–9A).

Normal intestinal villi of a baby pig are shown here with the aid of a scanning electron microscope. Note the extensive epithelial surface present for the absorbtion of nutrients (PN–2876).

A matter of villi

PARTIAL EXPLANATION of marked differences in susceptibility to transmissible gastroenteritis (TGE) between newborn and older pigs, along with insight into the unique mechanism for producing immunity, may be opening the way to more effective preventive measures.

TGE produces death losses approaching 100 percent in pigs less than 7 days old, but is less severe or even unnoticed in 3-week-old pigs. It is a highly infectious virus disease, sometimes accompanied by secondary bacterial infections, and is characterized by vomiting, diarrhea, and dehydration. TGE currently is responsible for more losses than any other disease of swine in this country.

At the National Animal Disease Center, Ames, Iowa, ARS scientists have pinpointed the damage produced by the TGE virus. Veterinary medical officers Harley W. Moon and George Lambert and microbiologist James O. Norman found that TGE produces atrophy of villi, the finger-like projections from the epithelium or lining of the small intestine.

Nutrients are absorbed via the villi. When villi become atrophied, the pig cannot digest and absorb milk. Pressure builds up in the intestinal tract, resulting in severe diarrhea and dehydration, which is the direct cause of death. The researchers found that atrophy of villi was more complete and more extensive in pigs exposed to TGE virus when 3 days old than in pigs 21 days old.

Two reasons for the difference are suggested in an earlier study by Dr. Moon. He found that cells of villi in newborn pigs are consistently older than comparable cells in 21-day-old pigs. First, cell regeneration after villus atrophy apparently is slower in very young pigs. Second, the scientists suggest that the ability of the TGE virus to grow is related to cell age—with virus growth more prolific in older epithelial cells found in the younger pigs. If so, these differences would help explain the greater susceptibility of new-born pigs to TGE.

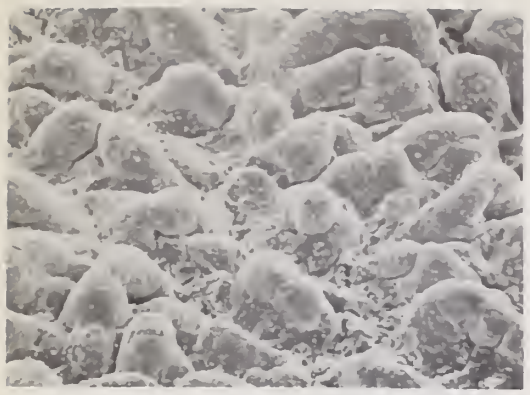
A subsequent study by Daryl D. Thake, Dr. Moon, and Dr. Lambert delineated changes in the epithelium after the TGE virus produces atrophy of villi. The villi become shortened and fused together, they found. Replacement cells proliferate but are destroyed before they mature and form finger-like villi.

The primary objective of preventive measures against TGE, then, is to protect epithelial cells of the small intestine against infection and destruction by the virus, especially in young pigs.

Sows infected 40 or more days before farrowing usually transfer what is termed lactogenic immunity to their litters in the colostrum, the first milk after giving birth. Protection of newborn pigs by antibodies transferred from the sow in colostrum is of paramount importance because pigs may not synthesize protective levels of antibody when exposed to TGE virus until they are 2 to 3 weeks old.

The mechanism of lactogenic immunity, Dr. Lambert says, is unlike that in any other known disease of man or animals. At present, this immunity can be provided only when pigs receive TGE antibodies by mouth at frequent intervals, as when they are nursing an immune sow.

If fed colostrum from an immune sow for 2 days and then removed from the sow, the pig will be susceptible if



Atrophy of the intestinal villus epithelium can be seen in this electron microscope view of tissue taken from a piglet infected with TGE. Such atrophy results in malabsorbtion of nutrients, diarrhea, dehydration, and death (PN–2877).

exposed to the TGE virus 4 days later. Administering antibodies, or antiserum, by a route other than orally, such as intramusculary or into the bloodstream, has been ineffective in experiments.

Studies underway at NADC are seeking more complete understanding of the transfer of immunity from the sow to her litter. Scientists are particularly interested in determining which classes of immunoglobulin, a colostrum protein having antibody activity, are most effective in protecting against the TGE virus.

Chemists Stanley S. Stone and Marshall Phillips and technician Sharon L. Stark found that three classes of immunoglobulin that may be present in colostrum—IgG, IgA, and IgM—are transferred to the blood serum of pigs from their intestine and perhaps offer a high degree of protection against the TGE virus. Their study suggests that an immunization program favoring development of IgA and IgM antibodies may be more effective in protecting pigs than a prolonged immunization program favoring development of the IgG class of antibody.

Further study of the TGE virus, its effects on pigs, and the mechanism for transferring lactogenic immunity should provide more definitive answers to these questions: How can pigs be protected against TGE by vaccinating the sow? How long before farrowing should she be vaccinated? □

Controlling rangeland brush

GRASS PRODUCTION on brush-infested rangeland and pastures can be increased 50 to 300 percent at a cost of only 20 to 30 cents per acre per year.

Keys to the increase are (1) sprayer trails, (2) pickup-mounted boom or mistblower sprayers, and (3) proper doses of herbicide.

The new method of brush control, developed by range agronomist E. H. McIlvain and research technician Cecil G. Armstrong, involves driving a pickup truck with mistblower at 10 mph along previously built sprayer trails spaced 100 feet apart, and applying a low rate of herbicide downwind. Wind speed should be less than 10 mph. A single operator can treat 120 acres per hour.

Experimenting at the U.S. Southern Great Plains Field Station, Woodward, Okla., the researchers found that best results are obtained using two nozzles elevated 35° above horizontal with orifices almost 1/16-inch in diameter and an operating pressure of less than 50 pounds per square inch.

These settings result in coarse droplets that fall rather than float. Drift is usually effective for 100 feet and it seldom exceeds 400 feet. By contrast, drift from a spray plane under the same wind and atmospheric conditions and using oil or an oil-water emulsion as a carrier usually exceeds 800 feet.

Sprayer trails are leveled 18-inch-wide tracks for the truck wheels. They need not be straight, but should be roughly perpendicular to the direction of the prevailing wind.

According to Mr. McIlvain and Mr. Armstrong, trailmakers can be built in various ways from any readily available materials. One that they report works well consists of a pair of 18-inch sweeps on a 3-point tool bar behind which are dragged 3-foot-long sections of used caterpillar track, stiffened to create a rasping action. One pass with the unit makes a satisfactory trail that will last 5 years or longer.

A second trailmaker was made from an old, narrow, wheeled plow frame with sweeps in front of and behind each of the two wheels. Still a third type was made from a parallel pair of 12-foot-long channel irons 12 inches wide by 4 inches deep fitted with 18-inch-wide crossbars to scrape off the hummocks and drag soil into the low spots.

The degree of kill on treated areas can be controlled to any desired level, depending on herbicide dosage and the number of annual applications. Doses of herbicide are usually 1 ounce of active ingredients of 2, 4, 5–T or 2 ounces of active ingredient of 2, 4–D in 1 gallon of water per acre. These rates will usually remove the leaves and result in some top-growth kill on susceptible plants.

Usually one treatment offers summerlong suppression of shinnery oak, sand sagebrush and most weeds. Two or three treatments are necessary for suppression of salt cedar.

Mr. McIlvain and Mr. Armstrong found that applying the low dosages for 2 consecutive years results in various percentages of root kill. For example, two annual sprayings thinned ragweed 70 to 90 percent, sand sagebrush 30 to 50 percent, and shinnery oak 40 to 60 percent. A third annual spraying increases kill sufficiently to allow near maximum grass growth. □

Dyeing cottons...two sides to the story

TRADITIONALLY, dyeing has been used to enhance the style and beauty of cotton textiles.

Now, ARS textile scientists have invented an entirely new dyeing technique that adds another dimension to imparting colors to towels and other cotton textiles such as denim and twills. The technique allows dyeing one side of the fabric one color and the other side an entirely different color.

Invented by a team of researchers at the Southern Regional Research Center, New Orleans, La., the new technique represents a spinoff from wash-wear and durable-press finishes developed at the Center during past years. Team members included chemists Robert J. Harper, Jr., Eugene J. Blanchard and Joseph S. Bruno, textile technician John J. Lofton, and physical science technician Gloria A. Gautreaux.

In making what they call a "restricted dye application," the researchers treat one side of the fabric with a modified wash-wear formulation, then dye the fabric with a reactive cotton dye. The dye has no effect on the treated side but colors the untreated side.

Following the dyeing, the fabric is washed in an acid bath to hydrolize and remove the "resister." The fabric, now free of chemicals and dyed on one side, is dyed again. Voila! a two-colored fabric.

The choice of colors used in the separate dyeing steps necessarily must be made very carefully, but this poses little real difficulty. With the wide variety of choices, an almost unlimited combination of colors and shades is available.

Moreover, modifications of the procedure, such as weaving treated with untreated yarns, and making designs on the fabric surface with the dye resisters, offer virtually unlimited combinations of colors and designs.

The dye-resisting chemical treatment is an inexpensive modified wash-wear formulation that includes a crosslinking agent, dimethylol ethyleneurea; a thickener, hydroxyethyl cellulose, to prevent the solution from penetrating the full thickness of the fabric; and a catalyst, zinc nitrate hexahydrate.

The crosslinked or treated portions of the cotton fabric are completely resistant to the activity of the reactive cotton dyes used in the research. These dyes are used in the finishing industry but the research is now being turned to adapting the process for use with the vat dyes which are in more widespread use in the industry than the reactive dyes because they are less expensive and offer superior color and light fastness and crock resistance. □

Thin leaves stymie cereal leaf beetles

WHEATS with thick leaves are more susceptible to cereal leaf beetle attack than those with thin leaves according to recent Yugoslav research. The findings are a significant contribution to the ARS small cereal grains resistance breeding program.

Thickness of leaves is determined by measuring the leaf mesophyll, the chlorophyll-rich tissue composing the bulk of the leaf between the upper and lower epidermis.

During a 3-year investigation, the Yugoslav scientists tested over 2,000 lines of wheat against the cereal leaf beetle. They graded resistance on a scale from zero (no eggs per 10 stems, no adult/larval feeding damage) to three (16 or more eggs per 10 stems, 30 percent foliage eaten by adults, 40 percent by larvae). One to 15 percent foliage eaten by larvae was graded one and considered highly resistant.

In general, spring wheat was more resistant than winter wheat. Seventeen of 58 spring wheat lines tested were completely resistant, and 26 were rated one on the scale.

No lines of winter wheat were completely resistant to beetle attacks, and only 84 samples of 1,978 tested rated one.

Correlating the scoring pattern of zero to three with mesophyll thickness, the Yugoslavs found that winter wheats had layers of mesophyll of 121 to 167 microns, whereas resistant spring wheats had mesophyll thicknesses of 118 to 126 microns.

As a result of the work, seed from 53 resistant cultivars of both winter and spring wheats of *Triticum vulgare, turg dum, dicoccum, durum,* and other varieties have been sent to the Small Grains Collection, Beltsville, Md.

Now available to plant breeders and other researchers, the cultivars are catalogued there as Plant Introduction numbers (PI) 377624 through 377677.

Research entomologist Richard V. Connin, East Lansing, Mich., the cooperating scientist for this ARS-sponsored research, says the Yugoslav work also confirms that plant breeders will be able to obtain resistance to the beetle through leaf surface pubescence, or hairiness. "Although the adult female beetle may feed on hairy leaves, she will not often oviposit on them," he says.

Earlier research at Purdue University, Lafayette., Ind., developed a very effective breeding line with the resistance afforded by the hairiness characteristic (AGR. RES., April 1973, p. 15). It is a soft, red winter wheat, ARS-indexed CI–15890, called Vel and has been released for further germ plasm research.

The Yugoslav work was conducted under the direction of Dr. Tomislav Tesic at the Institute for Small Grains, Kragujevac, Yugoslavia. □

Yearbook: Shopper's Guide

IN these times of high prices, consumers may be interested in the varied money-saving suggestions in *Shopper's Guide*, the 1974 Yearbook of Agriculture.

Written and designed to help the shopper buy the right product for the best price, the new Yearbook lays down guidelines to help shoppers make their own decisions, and do their own brand comparisons.

The 368-page, illustrated hardback is divided into six sections of consumer information: Food, Materials, Equipment, Gardening, Services, and Recreation. The authors, 14 of whom are ARS researchers, provide insights from research in their fields of expertise that should help shoppers buy wisely.

For example, practical information in the Food section includes chapters that tell how many servings a consumer can expect from a package of food, ways to combine foods to provide a desirable diet, and contains tables and facts about foods that may be used as replacements in meals. Information is also provided on nutritional labeling, food grades, and unit pricing.

The Material section covers brick, block, lumber, plywood, insulation, wiring, and many other subjects of interest to the energetic homeowner who likes to do things himself. And the home gardener will find the Gardening section filled with helpful ideas on buying seeds, planting gardens, trees, shrubs, and other plants.

The Equipment section covers kitchen appliances, laundry facilities, lighting fixtures, and furniture among other things. And if something breaks down, the Service section has chapters on appliance and car repairs. The section also contains chapters dealing with movers, shopping for credit, and services for older Americans.

The Recreation section tells of vacation activities—backpacking, fishing, bicycling, and close-to-home traveling—that require little or no gasoline.

Secretary of Agriculture Earl L. Butz notes that *Shopper's Guide* is a companion volume to the 1973 Yearbook of Agriculture, *Handbook for the Home*. Both books, based on Federal and State research, are oriented to the consumer-homeowner.

A copy of *Shopper's Guide* may be obtained for $5.70 at government bookstores in various parts of the country or by sending a check or money order to Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., 20402.

Nitrogen testing

A DYE METHOD that indicates how much nitrogen is in a given soil provides farmers with an invaluable nitrogen fertilizer management tool.

Knowing how much nitrogen is present in a soil tells growers what kind of nitrogen storage capacity their crop has access to and also provides guidelines for determining how much nitrogen fertilizer to use initially and how often to reapply the fertilizer.

In applying the new method, ARS soil scientist Truman W. Massee, adds an azo dye solution to a soil sample, mixes and centrifuges the sample, then measures the liquid in a colorimeter. Chemical adsorptive sites in the soil organic matter bind the dye's color and the resulting colorimeter reading shows how much organic nitrogen is present in the tested soil.

This dye method has been used previously to determine plant and milk protein content, but Dr. Massee is the first to adapt it to a soil test. The test is highly accurate, comparing favorably with the Kjeldahl test which is still used as the standard. However, whereas the Kjeldahl test requires up to 14 hours duration, Dr. Massee's test requires only about 40 minutes to complete. Dr. Massee's research was conducted at the Snake River Conservation Research Center, Kimberly, Idaho.

In the new method for testing soil nitrogen, Dr. Massee places soil samples that have been mixed with azo dye into a centrifuge prior to colorimeter reading (0874X1354–43).

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AGRISEARCH NOTES

Nutrient-rich oats

NEW OAT VARIETIES that are high in protein may hold additional nutritional bonuses—greater concentrations of important minerals.

ARS plant physiologist David M. Peterson says further increases in mineral concentrations would be desirable in oats—a cereal grain already highly regarded for its nutritional quality.

In studies at the National Oat Quality Laboratory, Madison, Wis., he found phosphorus concentrations of about 0.6 percent in Dal and Goodland varieties. That percentage is near the 0.7 percent phosphorus in rations considered optimal for some domestic animals such as starting chicks. Not all phosphorus in cereal grains is digestible by nonruminant animal, however.

Development of new varieties may reduce the need to supplement animal feeds with phosphorus and other minerals, Dr. Peterson says, but calcium and iron levels in oats are considerably below nutrition requirements for livestock. Breeding oats for higher levels of these two elements may be impractical.

In his studies on oats grown in two different years, Dr. Peterson and his coworkers found that high concentrations of phosphorus and zinc were associated with high concentrations of protein. Also postively correlated with protein were concentrations of magnesium, iron, and boron. Boron data were obtained from oats grown in one year.

Dr. Peterson said that oats grown in one year had significantly higher concentrations of potassium, iron, zinc, and manganese than in another year—a reflection of environmental differences. Variability of mineral concentrations among varieties, however, was consistent for both years. The study included the varieties Froker, Lodi, and Orbit in addition to Dal, Goodland, and one experimental breedling line.

Other scientists who participated in the research were chemist Vernon L. Youngs of ARS, and statistician Jerome Senturia, and crop physiologist Larry E. Schrader of the Wisconsin Agricultural Experiment Station, Madison.

When reporting research involving pesticides, this magazine does not imply that pesticide uses discussed have been registered. Registration is necessary before recommendation. Pesticides can be injurious to humans, domestic animals, desirable plants, and fish or other wildlife—if not handled or applied properly. Use all pesticides selectively and carefully.

Low-energy frost protection

A NEW SYSTEM for protecting orchards from cold weather provides excellent cold protection with much lower energy requirements than conventional orchard fuel heaters and wind machines.

Soil scientist John W. Cary, Snake River Conservation Research Center, Kimberly, Idaho, simulated an orchard enclosed under a screen cover, then used sprinklers to form a thin sheet of ice on the screen during the onset of freezing temperatures.

In preliminary field tests, Dr. Cary's screen-ice cover reduced the loss of heat so that twig temperatures could be kept sufficiently warm using only frequent light water applications inside the enclosure.

Although installation of the screen cover would be expensive, the outstanding frost protection that the ice-screen cover provides and the great energy and money it saves in maintaining orchard warmth, should outweigh the high initial investment.

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